CYTOLOGICAL STUDIES ON HIMALAYAN MELIACEAE

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THIS WOODY FAMILY is comprised of 52 genera and at least 1,000 species (Styles & Vosa, 1971) distributed throughout the tropics and subtropics of the world. Its importance to forestry rests on several valuable timbers such as the mahogany of the trade (*Swietenia mahagoni* and *S. macrophylla*), mahogany-like African woods, especially of *Khaya* and *Entandrophragma*, and toon of India. Meliaceous woods are prized for furniture and cabinet work. The family is represented in India by 50 species belonging to 18 genera of which 13 species are of commercial importance. *Chukrasia tabularis*, *Toona ciliata*, *T. serrata*, *Melia azedarach*, *M. composita*, *Aphanamixis polystachya* and *Dysoxylum binectariferum* are some of the important timber species studied presently.

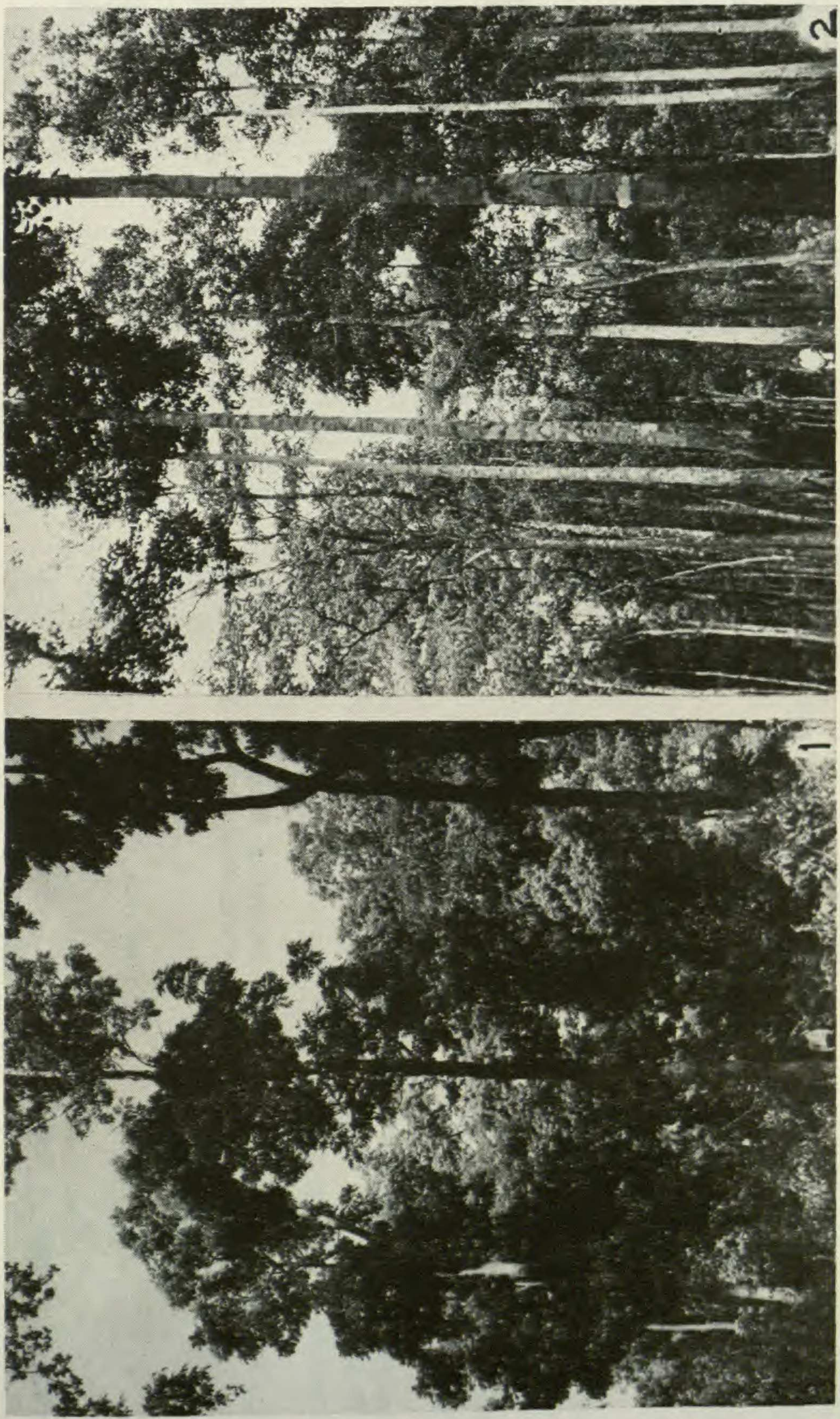
So far about 90 species belonging to 37 genera of Meliaceae have been reported cytologically, the maximum contribution being by Styles and Vosa (l. c.). These authors made mitotic observations with the exception of a single meiotic count. The present work is an attempt to fill lacunae in the cytology of the Himalayan members, chromosome counts for most of which have already appeared in IOPB reports (Mehra & Khosla, 1969; Mehra & Sareen, 1969). Our aim has been not only to know their chromosome counts but especially the process of meiosis, flowering season, and fruiting season, data which are prerequisite for any rational program for the improvement of trees.

MATERIAL AND METHODS

Material was collected from the wild in the forests of the Himalayas and the Khasia and Jaintia hills. Flower buds were fixed in Carnoy's fluid. Squashing of anthers was accomplished in aceto-carmine. For mitotic studies, root-tips were pretreated with .003 M solution of 8-hydroxiquinoline for four hours and squashed in aceto-lacmoid. Figures are at a uniform magnification of $\times$ 1360. Voucher specimens have been deposited in the Herbarium, Panjab University, Botany Department, Chandigarh-14 (India).

RESULTS AND DISCUSSION

Chromosome numbers of 24 taxa comprising 18 species belonging to 10 genera are listed in TABLE 1, which also includes data on specific localities of collection, previous counts for the species, and flowering and fruiting seasons. The course of meiosis has been found to be normal in all the taxa.



FIGURES 1 and 2, habit photographs. 1, *Chukrasia tabularis*, a tall tree with straight bole. 2, *Dysoxylum binectariferum*, an individual tree with straight bole.

TABLE 1. List of species studied, supplementary information, and chromosome numbers obtained

NAME	SOURCE	FLOWERING AND FRUITING PERIOD *		CHROMOSOME NUMBER	FIG. NO.	PREVIOUS REPORTS
CHUKRASIA TABULARIS A. Juss.	Darjeeling, Manjitar 300 m.	5–6	9–12	$n = 13$	3	$n = 13$: Rao, 1967
TOONA CILIATA M. J. Roem.	Darjeeling, Teesta 300 m.	3–5	5–8	$n = 28$	4	$n = 28$: Singh, 1951; $2n = 56$: Styles & Vosa, 1971
	Simla, Basantpur 900 m.			$n = 26$	5	
T. CILIATA var. PILLISTAMINEA C. DC.	Shillong, Barapani 800 m.	1–2	3–4	$n = 39$	6	
T. SERRATA (Royle) M. J. Roem.	Mussoorie, 1950 m.	5–6	9–10	$2n = 52$	7	
T. MICROCARPA (C. DC.) Harms	Darjeeling, Mahanadi 1500 m.	11–12	2–3	$n = 12$	8	
APHANAMIXIS POLYSTACHYA (Wall.) Parker	Darjeeling, Sukna 150 m.	9–10	2–3	$n = 18$	9	$2n = 72$: Minfray, 1963; Styles & Vosa, 1971
MELIA AZEDARACH L.	Darjeeling, Manjitar 300 m.	3–4	11–2	$n = 14$	10	$2n = 28$: Bowden, 1945; Pathak & Singh, 1949; Minfray, 1963;
	Nainital, 1950 m.			$n = 14$		Gadella et al., 1966; Styles & Vosa, 1971
M. COMPOSITA Willd.	Khasia & Jaintia hills, Garampani, 800 m.	3–4	winter	$n = 14$	11	

M. TOOSENDAN Sieb. & Zucc.	Khasia & Jaintia hills, Garampani 800 m.	5	9	$n = 14$	12	$2n = 28$: Minfray, 1963
AZADIRACHTA INDICA A. Juss.	Darjeeling, Teesta 300 m.	4–5	9–10	$n = 14$	13	$2n = 28$: Pathak & Singh, 1949
	Haldwani, 400 m.			$n = 14$		$n = 14$: Mukherjee, 1952; Deshmukh, 1959
						$2n = 30$: S. & G. Mangenot, 1958; Styles & Vosa, 1971
DYSOXYLUM PALLENS Hiern	Darjeeling, Sukna 150 m.	3–4	7–8	$n = 10$	14	
D. BINECTARIFERUM Hook. f.	Darjeeling, Sukna 150 m.	4–5	winter	$n = 40$	15	
D. HAMILTONII Hiern	Darjeeling, Manjitar 300 m.	10–11	2–3	$n = 40$	16	
D. PROCERUM Hiern	Darjeeling, Lebong 1800 m.	8–10	1–4	$n = 40$	17	
AGLAIA PERVIRIDIS Hiern	Darjeeling, Teesta 300 m.	5–6	12	$n = 20$	18	
A. EDULIS King	Darjeeling, Mahanadi 1500 m.	1–2	3 onwards	$n = 40$	19	
AMOORA WALLICHII King	Darjeeling, Teesta 300 m.	8–10	1–2	$n = 20$	20	
HEYNEA TRIJUGA ROXB.	Darjeeling, Sukna 150 m.; Manjitar, 300 m.	2–4	8 onwards	$n = 14$	21	$2n = 24$: Nanda, 1962; $n = 14$: Rao, 1967
	Nainital, Dogaon 1000 m.			$n = 14$		
CHISOCHETON PANICULATUS Hiern	Darjeeling, Teesta 300 m.	4–8	winter	$n = 23$	22	

* Numbers in this column represent months, e.g., 1: January; 2: February; etc.

Chukrasia A. Juss. includes one or two species distributed from South China to Indo-Malaya. The Indian species *C. tabularis* (FIGURE 1) is a much appreciated timber tree of the Sikkim Himalayas, Assam, the Andamans, Kanara hills of Deccan, Mysore and the western Peninsula. Dark pink blaze and a pink terminal pair of leaflets are diagnostic features for identification in the field. The chromosome count of $n = 13$ confirms Rao's (1967) identical report for the species.

Toona M. J. Roem. is a genus well known for its high grade timbers. *T. ciliata* and *T. serrata* are commercial timbers of India. The former is a morphologically variable tall tree of the tropical Himalayas, also found in central and southern India, which is confined mostly to mixed plain and sal forests. The species shows chromosomal polymorphism and exists in three cytotypes. The haploid count of $n = 28$ in an east Himalayan population agrees with similar findings of Singh (1951) and Styles and Vosa (l. c.). The chromosome numbers of $n = 26$ for a population from the western Himalayas and $n = 39$ for var. *pillistaminea* from the Khasia and Jaintia hills fall in the series of $x = 13$. *T. serrata*, a western Himalayan species with $2n = 52$, is again based on $x = 13$. *T. microcarpa* occurs in the middle hill forests of the Darjeeling hills. It is cytologically interesting in the sense that it adds a new chromosome count, $n = 12$, to the genus.

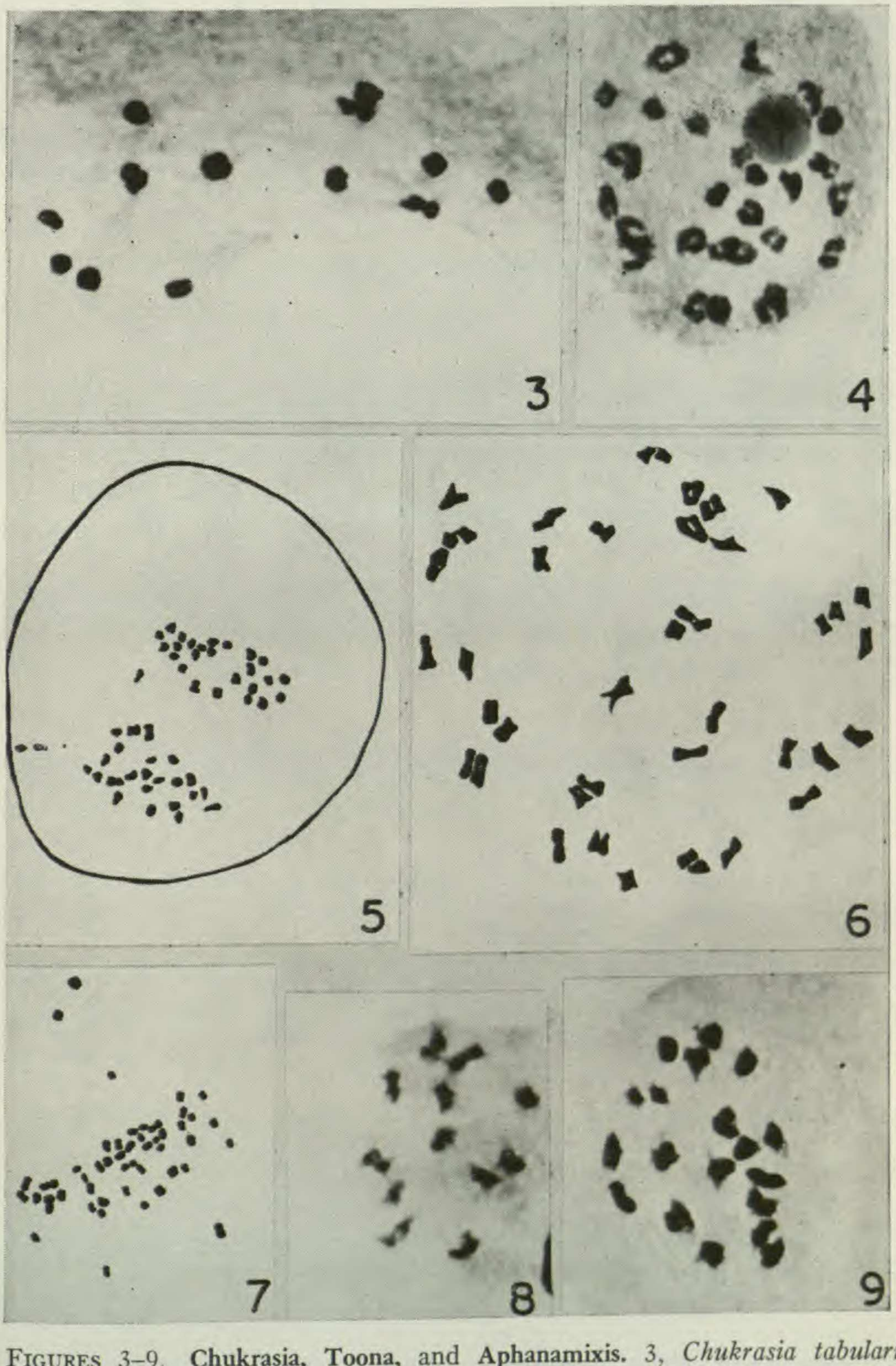
Aphanamixis Blume embraces 25 species, mostly confined to Malaya. The Indian representative, *A. polystachya*, is a medium-sized tree and a commercial timber of the Darjeeling hills. The present taxon having $n = 18$ is diploid, while Minfray (1963) and Styles and Vosa (l. c.) obtained tetraploid counts in this species where $2n = 72$.

Melia L. comprises 15 species. *M. azedarach* and *M. composita*, two Indian timbers, and *M. toosendan* uniformly reveal $n = 14$.

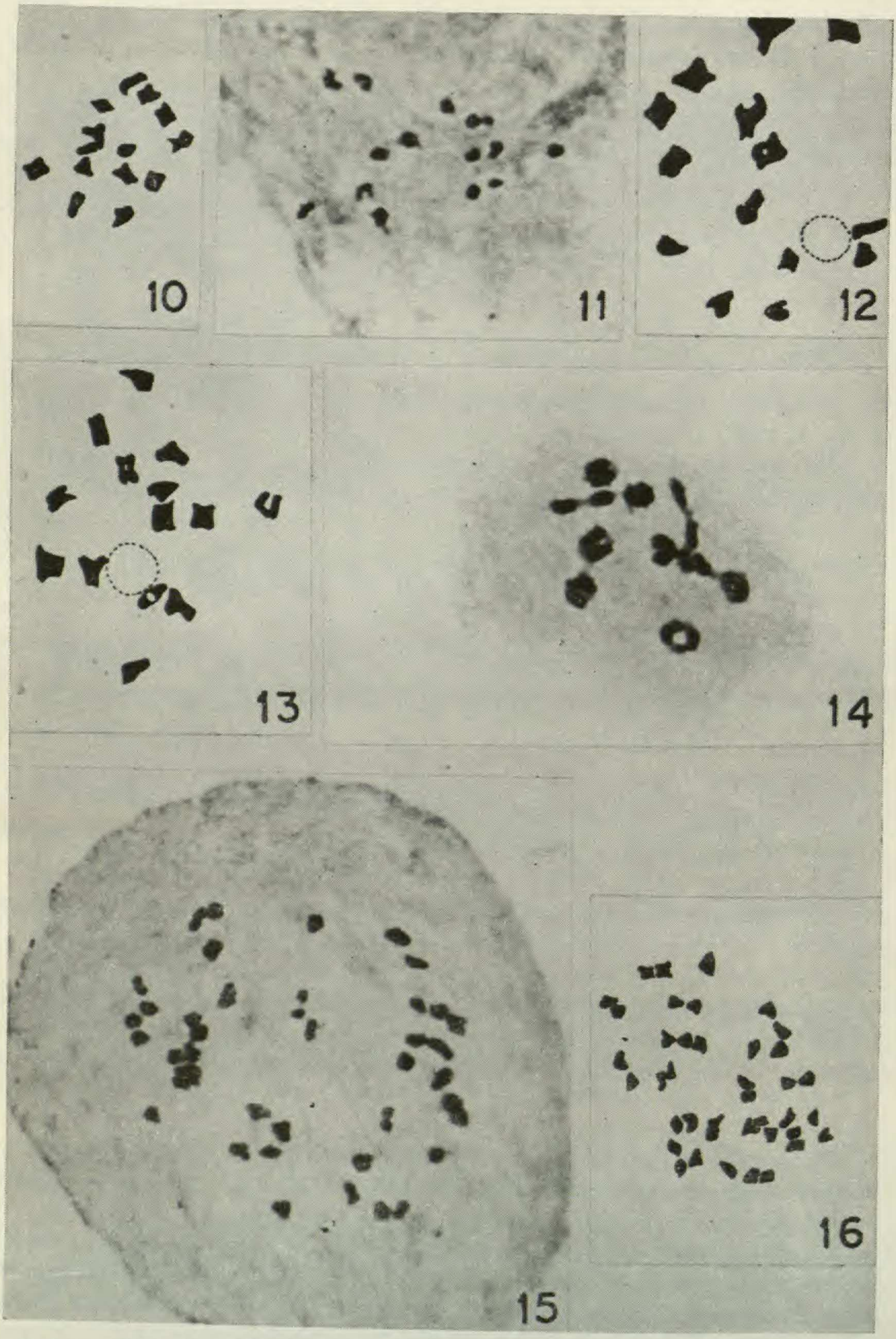
Azadirachta A. Juss. is a small genus of two species. *A. integrifolia* is found in the Philippines, while *A. indica* is widely distributed in the Indo-Malayan region and displays two chromosome numbers, $n = 14$, and $n = 15$ (see TABLE 1); the latter number might have arisen from the former by addition of one chromosome.

Dysoxylum Blume is another Indo-Malayan genus of 200 species of which seven occur in India. Four species which have been studied here are common in the sal and mixed plain forests of the Darjeeling Himalayas. Of these *D. binectariferum* yields timber of economic importance. The counts of $n = 10$ for *D. pallens* and $n = 40$ for *D. binectariferum*, *D. hamiltonii*, and *D. procerum* are the first cytological reports for these species. Other observations on the genus are *D. pachyphyllum* ($2n = 82$: Styles & Vosa, l. c.), *D. ramiflorum* ($n = 36$–38: Paetow, 1931) and *D. spectabilis* ($n = 42$: Beuzenberg & Hair, 1963). Ten is the lowest gametic number recorded in the genus, and it is suggested as the primary base number.

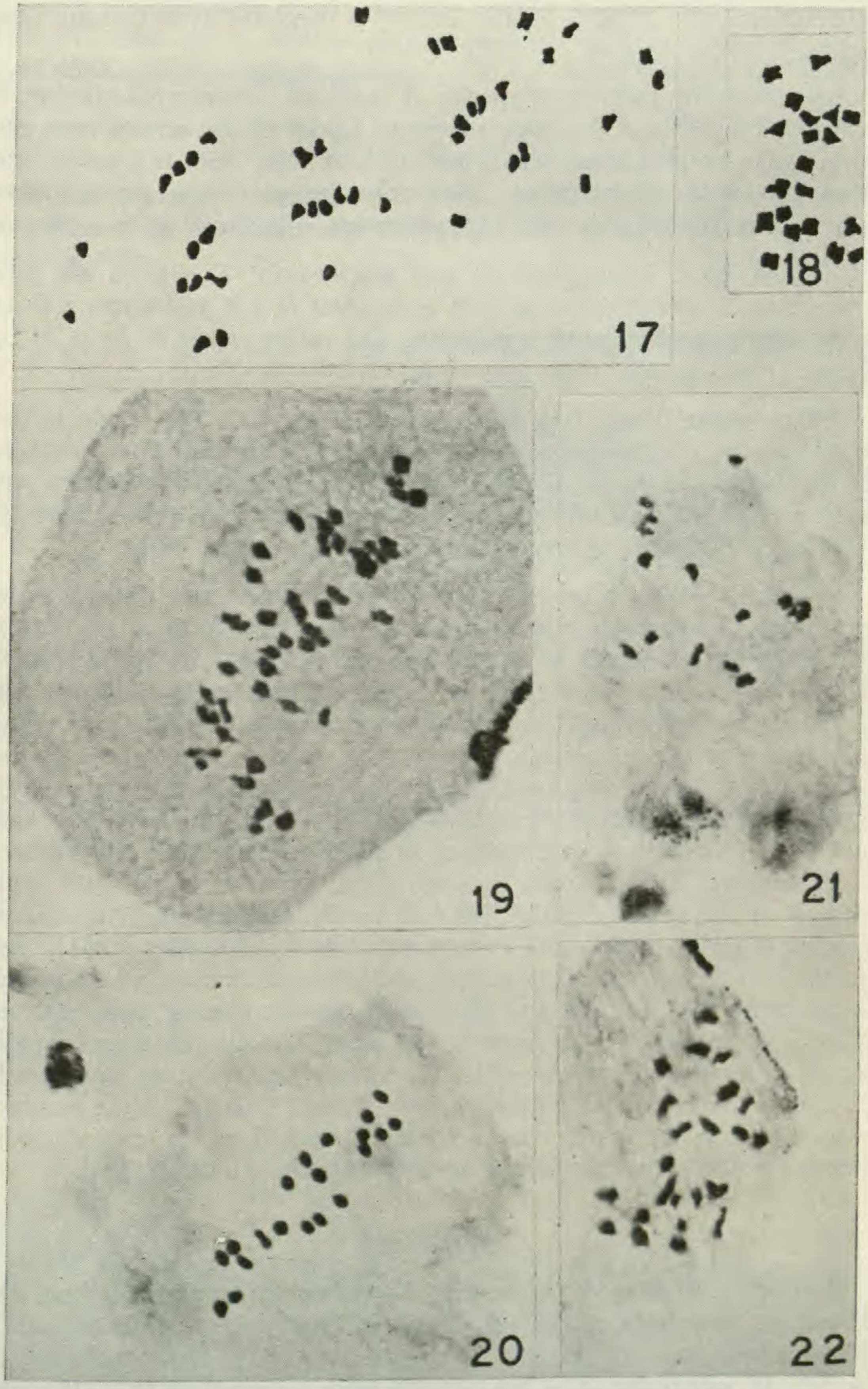
Aglaia Lour. is unimportant from the point of view of forestry. This genus is studied cytologically for the first time here, showing $n = 20$ in *A.*



FIGURES 3–9. **Chukrasia, Toona,** and **Aphanamixis.** 3, *Chukrasia tabularis*, M–I, $n = 13$. 4 and 5, *Toona ciliata*. 4, diakinesis, $n = 28$; 5, A–I, $n = 26$. 6, *T. ciliata*, var. *pillistaminea*, diakinesis, $n = 39$. 7, *T. serrata*, mitotic metaphase, $2n = 52$. 8, *T. microcarpa*, diakinesis, $n = 12$. 9, *Aphanamixis polystachya*, M–I, $n = 18$.



FIGURES 10–16, **Melia, Azadirachta,** and **Dysoxylum.** 10, *Melia azedarach*, diakinesis, $n = 14$. 11, *M. composita*, M–I, $n = 14$. 12, *M. toosendan*, diakinesis, $n = 14$. 13, *Azadirachta indica*, diakinesis, $n = 14$. 14, *Dysoxylum pallens*, diakinesis, $n = 10$; 15, *D. binectariferum*, M–I, $n = 40$; 16, *D. hamiltonii* M–I, $n = 40$.



FIGURES 17–22. **Dysoxylum, Aglaia, Amoora, Heynea,** and **Chisocheton.** 17, *Dysoxylum procerum*, M–I, $n = 40$. 18, *Aglaia perviridis*, M–I, $n = 20$; 19, *A. edulis*, M–I, $n = 40$. 20, *Amoora wallichii*, M–I, $n = 20$. 21, *Heynea trijuga*, M–I, $n = 14$. 22, *Chisocheton paniculatus*, M–I, $n = 23$.

perviridis and $n = 40$ in *A. edulis*. Twenty is suggested as its primary base number.

Amoora Roxb. includes 25 species. *A. wallichii*, a commercial timber, is distributed in India in the moist evergreen forests of the eastern zone and in Andaman. A pink blaze with a few beads of milky juice is a useful field character for its identification. The only species of the genus known cytologically, it shows $n = 20$. It is presumed to be based on $x = 20$.

Heynea Roxb. is comprised of four species only. *H. trijuga* has been consistently observed by us, as well as by Rao (l. c.), to possess $n = 14$ in east and west Himalayan populations. An earlier report of $2n = 24$ by Nanda (1962) appears to be erroneous.

Chisocheton Blume is a genus with 100 species. The single Indian representative, *C. paniculatus*, is a small tree of the mixed plain forests, in Terai, Duars, and the lower hills of Bengal and Assam. This species possesses $n = 23$, which is the only chromosome count for the genus. Twenty-three is the highest base number recorded in the present study.

Unlike most of the other tropical hardwood families, the Meliaceae present a great heterogeneity of chromosome numbers with $2n = 16$, 20, 22, 24, 26, 28, 30, 32, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 72, 78, 80, 84, 92, 100, ca. 280, and ca. 360 (cf. Styles & Vosa, l. c.). Evidently, the family has passed through an active phase of numerical chromosomal evolution leading to the delimitation of genera and species. Most of the species possess high chromosome numbers and are in all probability palaeopolyploids that have evolved from ancient extinct ancestors with low base numbers. The original base number of angiosperms is generally believed to lie between 6 and 8, 7 being the most widely presumed number for them, as well as for some primitive tropical woody families like Annonaceae (Raven & Kyhos, 1965) and Proteaceae (Johnson & Briggs, 1963). Approximately 33 percent of the genera of Meliaceae investigated so far fall in the series $x = 14$, although the lowest gametic number is 8, reported only in one instance in *Sandoricum koetjape*. The other commonly represented series seems to be $x = 18$. Both these series are high and could probably have arisen from 7 and 9 respectively. The rest of the numbers encountered in the family can be deduced from these by multiplication, stepwise reduction or addition, or by amphiploidy (FIGURE 23).

SUMMARY

Cytological studies of 18 species belonging to ten genera from the Himalayas have been carried out. Of these, *Chukrasia tabularis* ($n = 13$), *Toona ciliata* ($n = 26$, 28, 39), *T. serrata* ($2n = 52$), *Melia azedarach* ($n = 14$), *M. composita* ($n = 14$), *Aphanamixis polystachya* ($n = 18$), and *Dysoxylum binectariferum* ($n = 40$) are some of the important timber species studied presently. The lowest gametic number in the present studies is reported in *Dysoxylum pallens* ($n = 10$). Normal meiotic be-

havior is characteristic of all presently studied species. The family Meliaceae is known for the extreme polymorphism of chromosome numbers and most of these are palaeopolyploids.

ACKNOWLEDGMENTS

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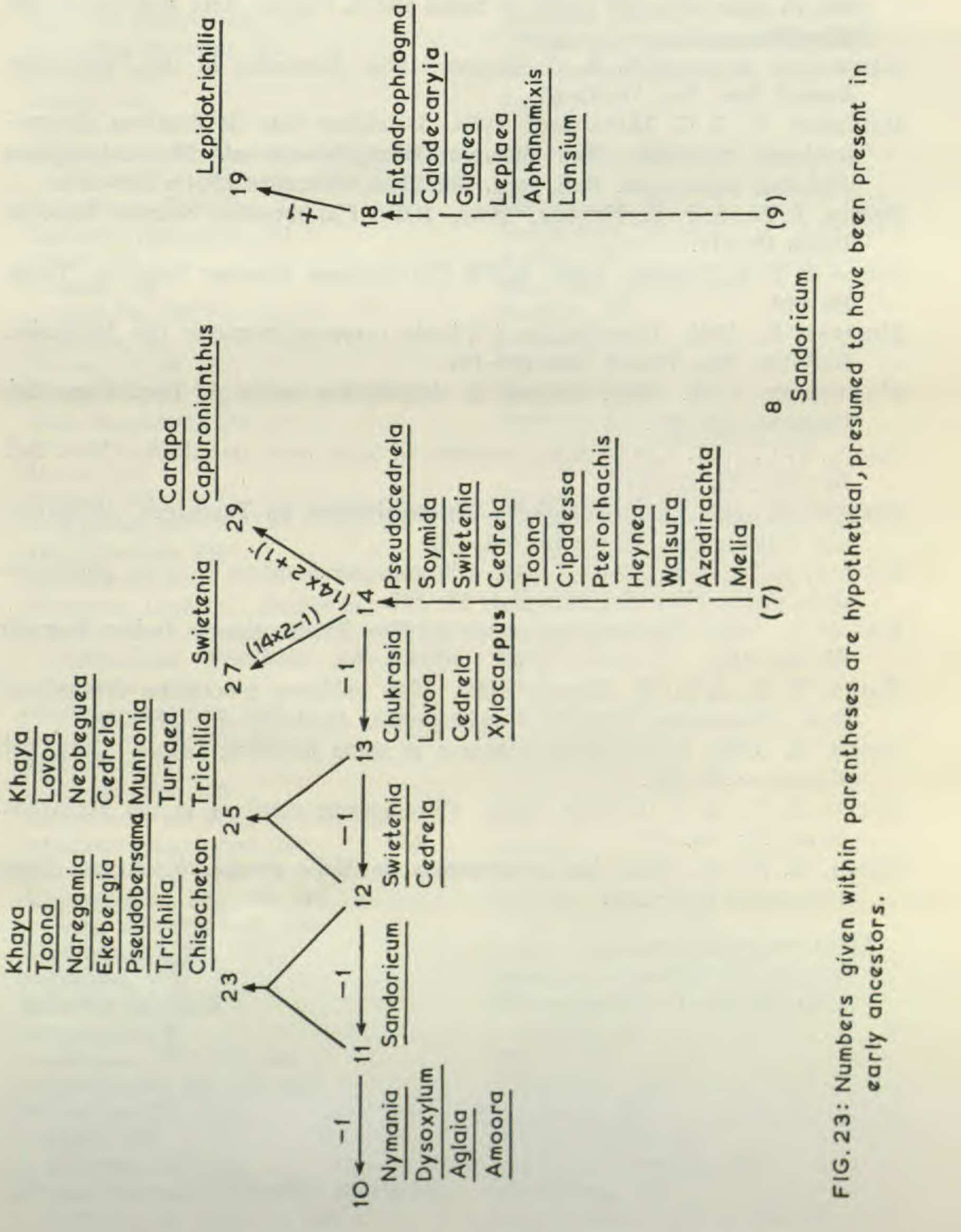

FIG. 23: Numbers given within parentheses are hypothetical, presumed to have been present in early ancestors.

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